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Original communication

Comparative analysis of sclerotic dentinal changes in attrited and carious teeth around pulp chamber for age determination

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ABSTRACT

Aim: The aim of this study was to estimate age by comparing sclerotic dentin thickness around coronal pulp chamber in carious and attrited teeth.
Methodology: Inclusion criteria for teeth selection was eruption age around six to seven years (incisors and first molars). 100 teeth (50 carious + 50 attrited) were ground up to their pulp chamber, observed and photographed under an Olympus stereomicroscope. Image J 1.38 NIH software was employed to analyze dentinal thickness.
Statistical analysis: Regression formula was employed for evaluating age and compared with clinical age obtained at time of extraction.
Results: No matching values were found between calculated age and actual clinical age.
Conclusion: Sclerotic dentin thickness values cannot be used as an indicator for the purpose of age estimation.

1. Introduction

Tertiary or sclerotic dentin can be defined as “the dentin deposited on the pulpal aspects of primary or secondary dentin, corresponding to areas of external irritation”.[1] Suggested terminologies for tertiary dentin include – irregular secondary dentin, reparative dentin, reactionary dentin and irritation dentin.

Reactionary dentinogenesis is defined as “the tertiary dentin matrix secretion by surviving odontoblasts, while reparative dentin is formed by new generation of odontoblast-like cells in response to appropriate stimuli”.[1]

In the present study, sclerotic dentinal changes in coronal dentin of carious and attrited teeth were observed using a stereomicroscope and morphometrically analyzed for any age-related relationship. The objectives of this study were to investigate the relationship between chronological age and estimated age derived from coronal sclerotic dentinal thickness, and also to determine whether the underlying causative mechanism i.e., physiologic and pathologic affects the sclerotic dentin thickness.

2. Material and methods

Study design comprised of a sample size of 100 teeth: 50 attrited and 50 carious extracted from patients aged between 20 and 50 years. The carious teeth were used as an internal control. Teeth included for study purpose were the central and lateral incisors and first molars (based upon eruption at six to seven years). Periodontally involved teeth, canines, premolars, second and third molars were excluded from the study.

Patient age was noted at the time of extraction and teeth were segregated accordingly. Each tooth was ground on Arkansas stone till the exposure of pulp chamber. An Olympus SXC7 model stereomicroscope was used to examine the sclerotic changes around the pulp chamber at 7.6× magnification and subsequently, photographed.

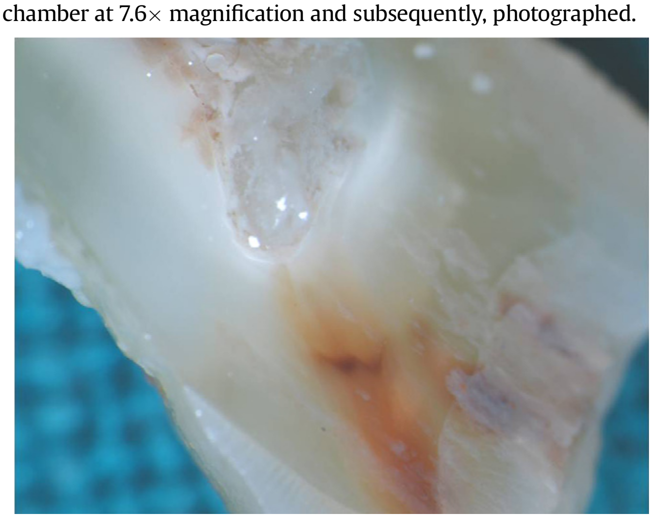

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Table 1
Mean sclerotic dentin thickness values with actual and estimated age in attritted teeth.

Mean sclerotic dentin thickness (mm)	Actual age (in years)	Estimated age (in years)
2.5–2.6	21–23 ($n = 8$)	29 (±2.0)
2.8–2.9	35–37 ($n = 4$)	25 (±1.0)
3.0–3.1	30–31 ($n = 12$)	25 (±0.5)
3.5–3.6	25 ($n = 16$)	45 (±1.5)
3.6–3.72	25 ($n = 12$)	35 (±1.9)
3. 75–3.8	40–42 ($n = 16$)	25 (±2.5)
3.9	50–55($n = 12$)	30 (±3.2)
4.0–4.2	20 ($n = 10$)	30 (±3.5)
4.5–4.6	25 ($n = 10$)	45 (±1.8)

Sclerotic dentin thickness was measured directly under the lesion at three adjacent points. Image J 1.38 software by NIH was used to measure sclerotic dentin thickness in all the specimens.

3. Statistical analysis

"Regression formula" proposed by Kvaal , Koppang and Solheim. was used for age estimation[2]:

$$\text{Age} = 26.9 + 2.0\ \text{SDT}\ (\mu\text{m})$$

where, SDT = Sclerotic dentin thickness.

4. Results and observations

Dentinal changes observed on analysis were:

1. Thin rim or band of structureless, non-tubular dentin representing tertiary dentin. In teeth with deep caries, tertiary dentin deposition was observed on floor of the pulp chambers.
2. Obliteration of tubular architecture nears the advancing carious front or in patchy, multiple areas located subjacent or adjacent to the lesion.
3. A translucent zone, which was not a consistent feature in majority of carious teeth examined.
4. Few teeth with dentinal caries (both, early and late) contained multiple incipient nidi of calcification in the pulp.
5. Periodic attenuation of dentinal tubules resulting in a zonal appearance.
6. Attrited teeth also exhibited identical structureless tertiary dentin deposition underneath the process front.

Regression formula analysis results were as follows:

Mean sclerotic dentin thickness values (Table 1) obtained revealed that the biologic age of patient at the time of extraction did not match with the calculated age using the regression formula. For example, for a mean sclerotic dentinal thickness of 2.5 mm, the actual age of patient was 21 years, whereas, the calculated age was 29 years. Similarly, for a thickness 4.5 mm, the actual and calculated ages were 25 and 45 years, respectively.

Table 2
Table showing sclerotic dentin thickness values in attritted and carious teeth.

Mean SDT in attritted teeth (mm)	Mean SDT in carious teeth (mm)	Actual age (in years)
2.5–2.6	2.8–3.0	21
2.8–2.9	3.5–3.6	35
3.0–3.1	4.0–4.2	25
3.5–3.6	3.8–3.9	45
3.6–3.72	2.6–3.0	35
3.75–3.8	3.9–3.92	25
3.9	4.5–4.9	30
4.0–4.2	3.7–3.75	30
4.5–4.6	2.5–3.2	45

Table 2 shows comparative data between the sclerotic dentin thickness values in attrited and carious teeth. No matching values were found when tooth specimens obtained from identical biological aged patients were examined. For examined, teeth obtained from 25 year old individuals demonstrated thickness values of 3.5 and 3.8 mm; 3.6 and 2.6 mm and 4.5 and 2.5 mm, in attrited and carious teeth, respectively. There was a wide variation in values obtained.

5. Discussion

Odontoblasts are highly specialized post-mitotic cells aligned in a palisaded monolayer at the pulpal periphery and are responsible for both the developmental and reparative dentin formation i.e., physiologic and pathologic processes. Tertiary dentinogenesis is classified into two variant processes: a) reactionary dentinogenesis and b) reactive dentinogenesis.[3] In reactionary dentinogenesis, tertiary dentin matrix is secreted by post-mitotic odontoblastic cells, whereas, in reactive dentinogenesis, the matrix is secreted by the odontoblast-like cells originating from pulpal stem cells. Both the processes occur in response to appropriate stimuli. Because of the episodic nature of dental caries, it is likely that the tertiary dentin deposited beneath the carious front, comprises of both reactionary and reactive dentin.[3] During mild tissue injury (e.g., enamel caries, early dentinal caries, attrition), odontoblasts localized beneath the damaged region up-regulate their dentinal secretory activity.[3] However, an injury of greater intensity (e.g., deep dentinal caries) causes localized odontoblastic necrosis. An odontoblast-like cell population differentiated from pulpal progenitor or stem cells replaces these cells. These cells i.e., the post-mitotic odontoblasts and the odontoblasts differentiating from pulpal precursors are responsible for secretion of tertiary dentin matrix.[14] Smith and Fish observed that this tertiary dentin matrix is secreted at specific loci which may be at the pulp–dentin interface or the peritubular/intratubular location.[1,3]

Fish in his study found no active pathologic changes in the pulp of attrited teeth and that the disintegrating products from these odontoblasts along with the bacterial by-products cause pulpal irritation resulting in persisting changes in form of 'dysplastic' matrix deposition.[3] Langeland and Tronstad reported presence of bacteria within cracks in attrited teeth.[4] In addition, according to Ketterl, there are 9000–24,000 odontoblastic processes per square millimeter at the dentinoenamel junction.[5,6] Thus, as the attrition process proceeds, more of dentin and odontoblastic processes are exposed and a continual deterioration of odontoblasts takes place.

Teeth erupting at biologic age of 6–7 years (i.e., central and lateral incisors and first molars) were selected in this study as they are exposed to intra-oral environment for equal time-period.[12] Both caries and attrition have been shown to influence the rate of peritubular deposit restricted to coronal dentin by Nalbandian et al.[7] Root dentin analysis was excluded from the study based on findings reported by Nalbandian, Cremasco, Silverstone and Mendis.[7–10] According to them, sclerotic dentin deposition in roots is mainly in response to periodontally compromised states representing an entirely different variable with difference in matrix deposition pattern and mineralization.[7–10,13]

Hence, only the coronal dentin was chosen in this study for analyzing sclerotic changes.

Silverstone[9] and Thyrlstrup and Qvist[11] published their findings based upon histologic preparations and SEM studies. Kvaal et al. in their SEM study counted the numbers of dentinal tubules as an estimation technique for age derivation.[2] However, the main drawbacks of these studies are the facts that dentinal tubules are

not completely circular in cross-section and sclerotic dentin deposition is highly irregular for counting to be exact.[15]

However, the results obtained demonstrated no age matching values between sclerotic thickness values between carious and attrited teeth and also between calculated ages obtained from regression formula and patient's biologic age.

6. Conclusion

Hence, it can be concluded from the study that sclerotic dentin thickness cannot be used as an accurate indicator for age estimation as it can be surmised that tubular obliteration is a resultant of various physiologic or pathologic state and is not just an age-dependent deposition.

Conflict of interest

There are no conflicts involved in this study.

Ethical approval

Institutional ethical committee clearance obtained.

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None declared.

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